CHAPTER IV

PRESENTATION AND IMPLEMENTATION OF INSTRUCTIONAL DESIGN

4.0 Introduction

The previous chapter described in detail the plan and procedure of the methodology for the study. The present chapter gives the development and implementation of the instructional designs based on constructivist approach to teach physics at diploma engineering level.

4.1 Considerations for planning instructional designs based on constructivist approach.

The constructivist sessions were planned to teach physics to the first year students at diploma engineering in civil and electrical branches at Butler Polytechnic affiliated to Gujarat Technological University in the year 2013-14. Students of Diploma in civil engineering were taken as control group and students of electrical engineering were taken as experimental group for the present study.

In the experimental group there were total 30 students from which five groups of 6 students in each group were made. From each group of 6 students, two students were assigned the role of recorders, one speaker and 3 performers. All the group members were shuffled after each session. Recorder wrote down the observations made during discussion of all group members, performers did the activities and one speaker from each group reported the proceedings in the group to the general class. Thus collaboration and team work was done during all sessions.

The 5 E model of constructivist approach was used to develop the instructional designs of the constructivist sessions developed by Bybee. R. (2009), Biological Science Curriculum Study Centre (BSCS), emphasizes that learners constructs new ideas over their old ideas. The 5 E's can be used with students of all age groups.

Each E in the E's model focuses a learning phase beginning with alphabet E. i.e. Engage, Explore, Explain, Elaborate, and Evaluate. It employs the process of

teaching-learning to explore to the common activities, developed on prior knowledge and experiences, making and constructing meaning, and continually assessing the understanding of a concept.

Step 1: Engage: This phase of the 5 E's starts the process. An "Engage" activity focuses on:

Making connections between past and present learning experiences and anticipating activities and focus students' thinking of current activities based on the learning outcomes. Students are engaged mentally in the teaching-learning process to the content to be taught.

Step 2: Explore: This phase provides a common base of experiences to students. They identify and develop concepts, processes and skills. Students are actively explored to their environment and allowed to manipulate materials and formulate a basis for new knowledge.

Step 3: Explain: This phase promotes s teacher to explain the concepts which they have been exploring. They can be given the opportunities to verbalize their conceptual understanding or demonstrating new skills or behaviors. Teacher conceptual explanation or introduction to formal terms is done in this phase.

Step 4: Elaborate: This phase elaborates and extends conceptual understanding of students by allowing skills to be enhanced. Learners develop deeper and broader understanding of major concepts through the experiences given to them, obtaining more information about areas of interest, and refining their skills.

Step 5: Evaluate: This phase encourages learners assessing their understanding and abilities and allows teachers to evaluate or test students' understanding of key concepts and skill development based on learning objective.

Students were given home assignment wherein they had to make project files wherein real life applications and transfer of training skills was to be evaluated, depending upon the learning and objectives of the contents of the respective units of constructivist sessions.

4.2 Plan of Implementation

The constructivist sessions were made for three common units in civil and electrical diploma engineering. Each unit had four sessions of instructional design each of one hour. Each instructional design has two sections. Section A and Section B. Section A deals with the constructivist instructional design. Section B deals with various handouts. Section B is presented as appendix No. 4 in appendices. The instructional designs were planned with mix and match designs as required by the contents of the units. The photographs are attached in the appendix 6, video recording was not permitted in the institute.

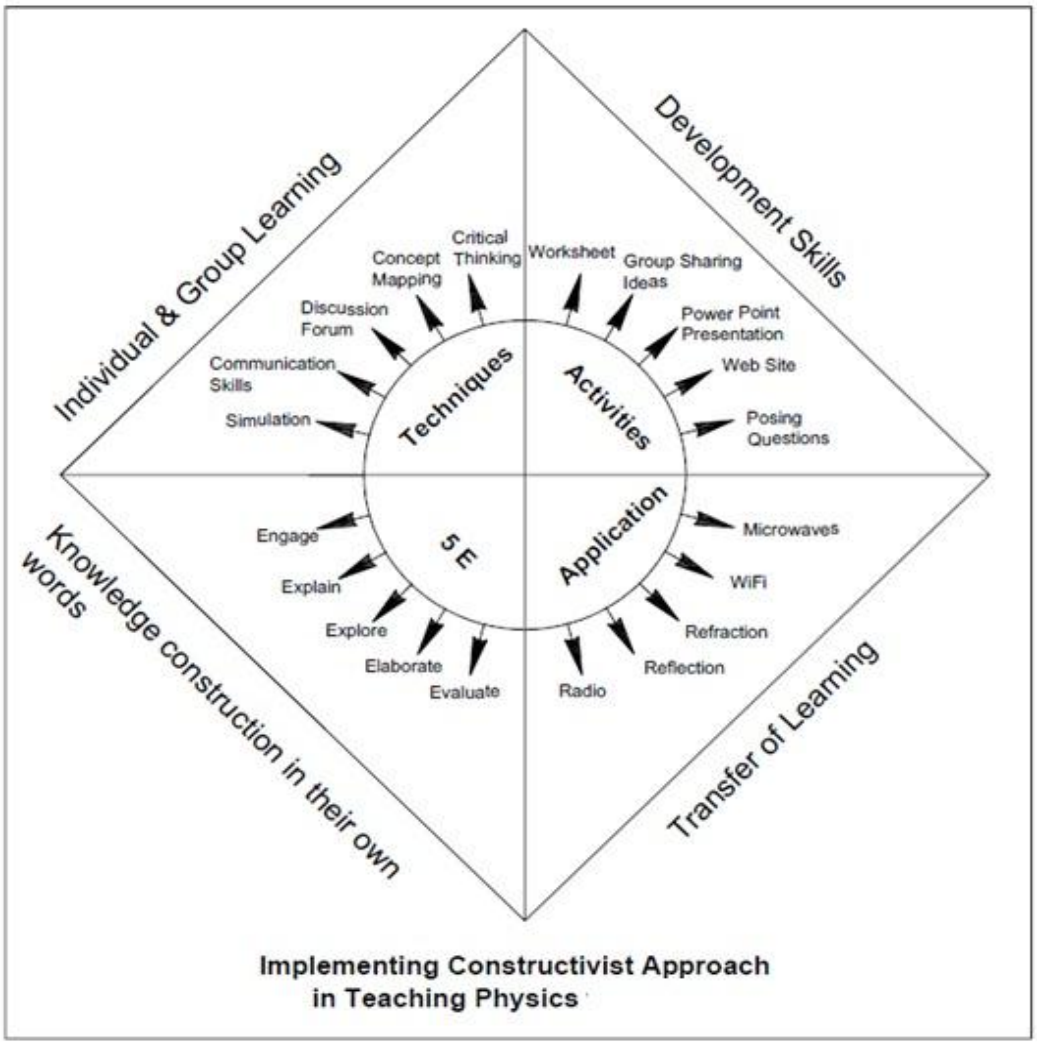


Figure 4.1: Implementing Constructivist Approach in Teaching Physics

The contents of the three units are mentioned below:

Unit I: System International (SI) Units and measurements

- Measurement and unit in engineering and science, definition of unit, requirements of standard unit, system of units- Centimetre Gram Second (CGS), Metre Kilogram Second (MKS) and System International SI Units.
- Fundamental and Derived quantities of Units.
- Least Count and range of instrument, least count of Vernier Calliper, micrometer screw gauge
- Definition of accuracy, precision and error.

Unit II: Sound and Waves

- Wave Parameters: wave motion, amplitude, period, frequency and wavelength
- Types of Waves: Longitudinal and Transverse waves
- Interference and its types: Constructive and Destructive Interference
- Principal of Superposition of Waves

Unit III: Light

- Properties of light: Reflection and Refraction of Light
- Dispersion of light
- Resonance of light
- Interference of light

Section A

4.3.0 Unit I: System International (SI) Units and measurements

- Measurement and unit in engineering and science, definition of unit, requirements of standard unit, system of units- Centimetre Gram Second (CGS), Metre Kilogram Second (MKS) and System International SI Units.
- Fundamental and Derived quantities of Units.

- Least Count and range of instrument, least count of vernier Calliper, micrometer screw gauge
- Definition of accuracy, precision and error.

4.3.1 Instructional Designs for unit I: SI Unit and Measurement

Instructional design I covers the following topics of the contents of unit I:

- Measurement and Unit in Engineering and Science.
- Definition of Unit and its properties.
- Different Systems of Units

Objectives:

- The students will be able to measure the materials based on different units.
- The students will be able to define basic units in SI System.
- The students will be able to state properties of a unit.
- The students will be able to compare different systems of units.
- The students will be able to convert units into different system of units.

The instructional design followed the following five phases of 5E's:

Measurement of objects and their units

Step 1: Engage: Students were individually assigned the activity sheet as shown below to measure the given materials provided indicating the unit and record their observations in the measurement record sheet.

Materials Required: Wooden Blocks, Metallic Blocks, Thermometer, Chalks, Pencils, Erasers, Piece of cloth, Watch Sharpener, Graduated Cylinder, Ruler

Table 4.1: Measurement Record Sheet

Sr. No.	Material	Area/Size/Temp.	Unit
1	Wooden blocks		
2	Metallic blocks		
3	Thermometer		
4	Chalks		
5	Pencils		
6	Eraser		
7	Piece of cloth		
8	Watch		
9	Sharpener		
10	Graduated Cylinder		
11	Ruler		

Students measured all the materials provided and recorded their observations as per activity sheet.

Step 2: Explore: Sharing of individual learning experience in the larger group and discussion for more clarification.

Then one speaker from each group shared the observation on blackboard. Then discussion on measurement regarding system of units was done.

Step 3: Explain: Teacher explaied the content of the Unit to the students. The handouts are attached in section B. Questions will be posed to students regarding the types of units like:

- Name the different systems of units.
- What is the length of the full chalk you measured?
- What is the difference between centimeter-meter-kilometer or second-minute-hour, etc?
- In what system of units do foot, pound, second occur?
- In what system of unit meter, Kilogram and second measured?

Step 4: Elaborate

Students were provided with additional study materials in section B on Handout. They were asked to study them on their own.

Discussion among students as per section 4.1

Activity Sheet 2 was given to students, wherein different units were written and students were asked to fill up the sheets by writing formulas and SI units of the physical quantities.

Table 4.2: Formulas and SI units of physical quantities

Sr. No.	Units	Formula	S I Unit
1	Length		
2	Area		
3	Volume		
4	Time		
5	Velocity		
6	Work		
7	Frequency		
8	Mass		
9	Current		
10	Surface Tension		

Discussion was done in class on the difference between derived units and fundamental units to assess the learning. Giving students the opportunity to expand and consolidate their understanding of the concept of different types of units.

Step 5: Evaluation: Students were given the assignment to do at home of making the project file for measurement of the screen size of appliances like computer screens, Smart TV, LED TV, Computer Monitor and Smart Phones.

4.3.2 Instructional Design 2: Vernier Callipers Duration: 1 hour

Objectives

- The students will be able to explain the Principle of Vernier Callipers
- The students will be able to explain Construction and Working of vernier Calliper.
- The students will be able to understand the Least Count and its range.
- The students will be able to identify errors in it.
- The students will be able to understand the Applications of Vernier Calliper

Step 1: Engage: Capturing the students attention stimulating their thinking and helping them access prior knowledge by questioning

Q1. What do you need to measure a physical quantity accurately?

Q2. How can you measure the length of an object?

Q3. How to measure the fraction of an mm?

Q4. How do you measure the thickness of sheet?

Step 2: Explore: By giving vernier Calliper to each group of three students.

Posing questions to students: Giving time to students to think and investigate.

Q1. How many scales does it consist?

Q2. Which are they?

Q3. What does the main scale resemble?

Q4. What is the length of one main scale division?

Q5. What is the number of vernier scale division?

Q6. 10 vernier scale divisions equal to how many main scale divisions?

Q7. Then, n vernier scale divisions equal to..?

Q8. What is it called?

Step 3: Explain: Teacher explained the content of the unit to the students. The hand-outs are attached in Appendix 4-Section B.

Step 4: Elaborate

Activity: By giving different metallic sheets students measured the thickness as per the activity sheet.

Table 4.3: Measurement of Thickness of Metallic Sheet

Sr. No.	Object	Reading on MSD cm	Reading on VSD		A + B cm	Avg. cm
			N=A cm	N X LC= B cm		
1	Metallic Sheet 1.					
2	Metallic Sheet 2.					
3	Graduated cylinder					

Discussion among students in groups: as referred in Section 4.2

Step 5: Evaluation: Make a Project File to measure the thickness of wires of

- Telephone cables
- Dish T V
- GTPL connections
- Earthing wire
- Laptop charger wires
- Computer C P U wires
- Explain the construction of vernier Calliper with a suitable diagram and write errors in it.

4.3.3 Instructional Design 3 Micro meter screw gauge Duration: 1 Hour

Objectives

- The students will be able to explain the Principle of Micro metre screw gauge
- The students will be able to explain the construction of micro meter screw Gauge.
- The students will be able to understand the errors in Micro meter Screw Gauge.
- The students will be able to explain applications of Micro meter Screw Gauge.

Step 1: Engage Capturing the students attention, stimulate their thinking and help them access prior knowledge by questioning.

Q1. What is the smallest measurement a vernier Calliper can do?

Q2. What is the least count of Vernier Calliper?

Q3. What can be used to measure thickness less than 0.01 cm?

Step 2: Explore

Posing Questions to students:

- How many scales are there in a micrometer screw gauge?
- Which are they?
- What is the smallest division on the main scale?
- What is the number of divisions on the circular scale?
- What is the use of the screw?
- What is the pitch of a micrometer gauge?
- What is the L.C. of a micrometer screw?
- How is the pitch of the screw determined?
- Is there any error in the micrometer?

Step 3: Explain: Teacher explained the students micrometer screw gauge. Hand outs are attached in appendix 4- section BBy giving Micrometer screws and different metallic sheets and diameter of a wire.

Step 4: Elaborate: Materials were provided to students who were to measure the thickness of the metallic sheet and fill in the activity sheet.

Materials Provided: Metallic sheets, wires, micrometer screw Gauge

Table 4.4: Measurement of thickness of the given materials by Micro meter screw Gauge

Sr. No.	Object	Reading on Main Scale – A(cm)	Reading on circular scale – B(cm)		A + B	Average A+B
			B=N	B=L.C. X N		
1.	Metallic Sheet					
2	Diameter of wire					

Discussed the reading of Micro meter screw gauge in all the groups.

Step 5: Evaluate: Answer the questions in the project file

- Why is Micrometer screw used?
- Explain the construction of a micro meter screw Gauge with suitable diagram and write errors in it.
- What is a pitch in a Micrometer screw?
- What is more precise: A Vernier Calliper or A Micrometer screw gauge?
- What is the difference between Vernier Calliper and Micro meter Screw Gauge?

4.3.4 Instructional Design 4: Accuracy and Precision Duration: 1 Hour

Objectives

- Students will be able to explain accuracy in scientific terms
- Students will be able to explain precision in scientific terms
- Students will be able to differentiate between accuracy and precision
- Students will be able to apply concept of accuracy and precision in real life situation

Phase 1: Engage: Power Point Presentation was shown to students.

Figure 4.2: Time line in sports

Watching the clips of movie Bhaag Milkha Bhaag wherein calculation of time and distance is done very precisely to reach the target.

Teacher asked students what they have observed in the clips.

Students answer the importance of speed with respect to time and distance.

Teacher brought the concept of accuracy by another activity.

Capturing the students attention, stimulating their knowledge and thinking and help them access prior knowledge by questioning:

Materials provided: Wrist watches, alarm clock, digital clock and mobile handsets to be given to each group of students and asking them to see the time (present).

- What is the time in all of your watches?
- What is the time in all of your Mobiles?
- What is the time in all of your alarm clocks?

Step 2: Explore: The standard time was to be written on the black board and the students were asked to fill the following activity sheet:

Table 4.5: Measuring present time

Sr. No.	Time-Standard A	Time Observed			Deviation – A		
		Wrist Watch	Mobile	Alarm Clock	1	2	3
1							
2							
3							

Step 3: Explain: Teacher explained the content of the lesson. Hand outs attached in appendix 4- section B

Step 4: Elaborate: Vernier Calliper and Micrometers screws was given to all groups of students and metallic sheets were given.

Students were asked to note down the observations in the following activity sheet:

Table 4.6: Measuring thickness of metallic sheets by Vernier Calliper and Micrometer Screw Gauge

Sr. No.	Thickness of Object	Reading of Vernier Calliper	Reading of Micrometer Screw	True Value	Deviation	Accuracy	Precision
1	Metallic Sheet I						
2	Metallic Sheet II						

After filling activity sheet the questions were posed to students as:

- What is the reading of Metallic Sheet I by Vernier Calliper?
- What is the reading of Metallic Sheet I by micrometer?
- Which value is more accurate with Vernier Calliper?
- Which value is more precise with micrometer?
- Which of the Vernier Calliper or micrometer is more precise?
- Why is micrometer more precise?

Step 5: Evaluate

Following questions were given to students to write in project files:

Define accuracy.

What is precision.

Vernier Calliper is more precise than micrometer screw gauge. State True or False.

What are the factors of precision?

What is the difference between accuracy and precision?

4.3.5 Participant Observation for unit 1: SI system and Measurement

- Most of the students measured the given materials individually and wrote the measurements with units in the activity sheets given to them, while few took help of their friends in measuring the materials.
- All of the students formed the groups and performed the roles of speaker, recorder and performer and shared their readings in groups.
- A few students discussed their measurements of the materials and their units with their group members and helped each other that who's reading were wrong. Likewise students created and confirmed their knowledge on measurement in group.
- All of the students shared their knowledge on behalf of whole class with the roles of speakers assigned to them.
- All the students listened to the explanation carefully by researcher to the contents of SI system.
- All of the students answered the question carefully by thinking to the questions posed by the researcher.
- All of the students helped their group members to write the correct formulas of the derived quantities.
- One of the students said "yes, now I have understood how the formula of surface tension is derived from its definition force per unit length and its unit is newton per meter, as it is a derived quantity'. So, students arrived at the complete knowledge of the concept of fundamental and derived quantities when the group discussion was done.
- One of the student said "I understood how screen size of Television is measured diagonally, as my readings were wrong when I measured its length". So students created their knowledge in evaluation step of the instructional design.
- One of the recorder students wrote the unit of length as 5 cms, to which he was corrected by his group member that symbols are not written in plural form. To which the student said: "I always wrote unit in plural and was mistaken in the rules followed to write the units of the quantities". So, student's misconceptions were clarified when they were given the opportunity to work in group.
- Most of the students personalized their knowledge by reflecting on the concepts of physics taught in the evaluation step.

- Students who finished taking readings helped their group members in taking reading by Vernier Calliper and micrometer screw gauge.
- A few students had a difficulty in measuring by Vernier Calliper in finding the coincident division of Vernier Calliper to main scale. The group members helped each other in taking the correct readings by sharing their knowledge.
- All the groups matched their readings and had found true to measured readings of the materials, on which they were very enthusiastic.
- One student said: “Now I will enjoy more in funfair in dart game to know my shots are more accurate or precise, as I m always precise in shooting darts but my friends are accurate, by understanding the application and difference between accuracy and precision”.

4.4.0 Unit II: Sound and Waves

- Wave Parameters: wave motion, amplitude, period, frequency and wavelength
- Types of Waves: Longitudinal and Transverse waves
- Interference and its types: Constructive and Destructive Interference
- Principal of Superposition of Waves

4.4.1 Instructional Design 5 Waves **Duration: 1 Hour**

Objectives:

- Students will be able explain the characteristics of waves
- Students will be able to describe the types of waves
- Students will be able to define terms Wavelength, Frequency and Amplitude.

Introduction: Power point presentation of different kinds of waves will be shown.
Tsunami waves
Cyclones
Tornado

Figure 4.3: Clips of different types of waves

Teacher posed questions to students.

Q1 What do the clips represent?

Q2 What is the difference in waves of all clips?

Q3 Why is it so?

Step 1: Engage: Capturing students attention, stimulating their thinking and help them access knowledge by questioning:

Q1.What are different types of waves?

Q2.What are waves?

Q3.How does the sound waves move?

Q4.From where do all waves come from?

Q5. Why are waves energy-mobile?

Q6. What is observed in a wave which is moving against it?

Q7.Which are the two types of waves?

Step 2A: Explore

Experiment1: Demonstration of longitudinal waves is done in the following experiment. By tying the rope at one end of the room and gluing a piece of paper in the middle of the tape. Then asking one student to pull the rope so that it is back slit. Then by vibrating the arm rope will vibrate producing longitudinal waves that are parallel to the medium.

Materials required:

- A ten feet long rope and a Coloured tape.

Tie a rope on end of the room.

Putting a piece of tape at the middle of the rope.

Now pulling the rope a bit slack not touching the floor.

Vibrating arm upside and downside and observing the pattern of waves generated.

Now vibrating your arm many times and carefully observing the result.

Also observing the movement pattern of the tape which is tied in the middle of the rope.

Step 3: Explain: Teacher explained to student's contents of the unit. Handouts are attached in appendix 4- section B for further learning.

Step 2B: Explore

Experiment 2: By giving one end of the slinky to one student in which middle is coloured red, the other student pulling the other end of the slinky down by stretching and pulling it back. This will demonstrate transverse waves which flow perpendicular to the medium.

Materials required:

- A Slinky
- Two Students
- A tape-colored

Sticking in middle a piece of tape on one slinky wire.

Asking any one student to come forward and hold the end of the slinky.

Asking second student to stretch the slinky two meters, not too far.

Quickly pushing the slinky towards one student and then again pulling it again to its initial position,

Asking student if they observed the wave created?

Repeating the same several times and watching where the slinky is compressed or rearefacted.

Observing the tape patterns.

Posing questions to students:

Which waves are produced here?

What is longitudinal wave?

Did you look at the tape?

Can you classify the patterns of a transverse wave and a longitudinal wave?

Step 4: Elaborate: The distance between two consecutive crest or trough of the wave is called its wavelength.

Wavelength is related wave frequency.

Frequency of the wave is in reciprocal to the wavelength of the wave.

Here, frequency is no of oscillations per second.

If wavelength of a wave is large then its frequency will be small and vice-versa.

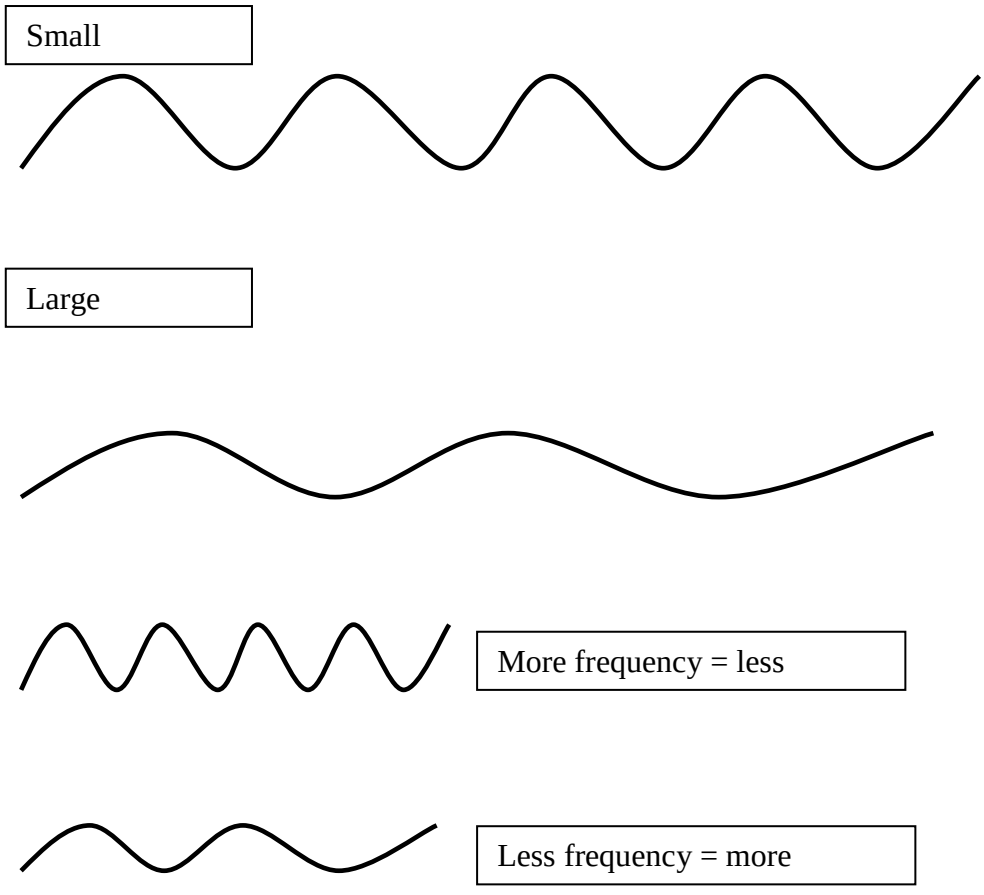


Figure 4.4: Wave Frequency

Amplitude

Amplitude is the height of the wave.

The higher the amplitude, the higher the energy of the wave.

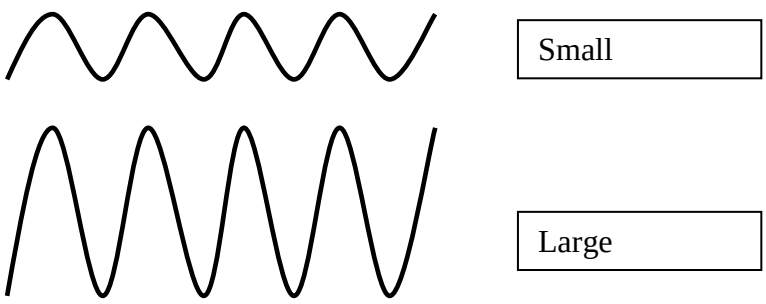


Figure 4.5: Wave amplitude

Consolidation

Thus, basically there are two types of waves. Longitudinal which are the parallel direction of the propagation of the medium

Transverse waves which are perpendicular to the direction of propagation

Wave length is the distance between two like parts of the wave.

Frequency is the number of oscillations per second.

Amplitude is the height of the wave.

Step 5: Evaluate: Students were given following questions to write in project file:

Q1. Who has high pitch: A girl or a boy.

Q2. Whose amplitude is higher: A DJ or a Radio? Why?

Q3. Which types of waves are used in Wi-Fi?

Q4. Which of the following has the longer wavelength?

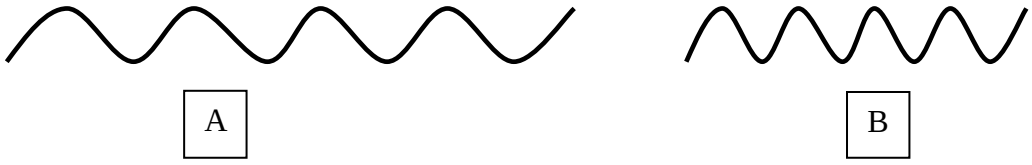


Figure 4.6: Wave Length

Q5. Which of the following has the larger amplitude?

Figure 4.7: Wave Amplitude

4.4.2 Instructional Design 6: Wave Parameters Duration 1 Hour

Objectives:

- The student will observe models of transverse and longitudinal waves and identify parts of each wave type.
- The student will identify wave types based on the direction of particle motion in relation to the direction of propagation.
- The student will apply knowledge of wave behavior through media and across boundaries and make predictions about expected behavior.

Step 1: Engage:

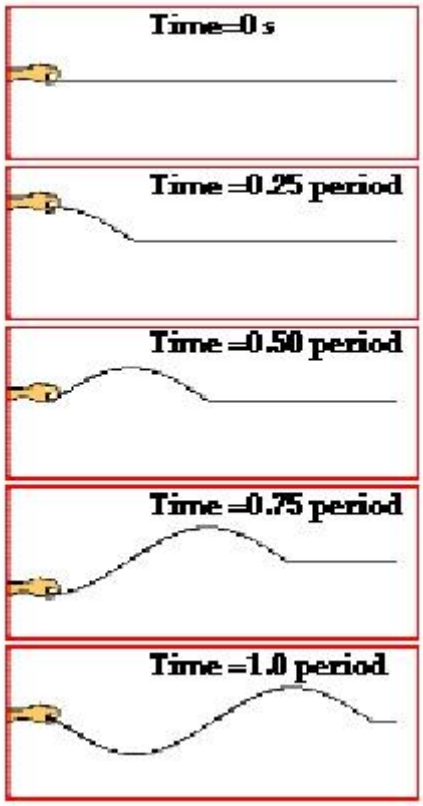


Figure 4.8: Wave Motion

Power Point Presentation will be shown:

Step 2: Explore Following questions were posed to students

- What is observed in slide?

- Does it create any wave pattern?
- What is the frequency of source and individual particle?
- What is the time period of source and individual particle?
- Describe wave cycle.

Step 3: Explain: Teacher explained to students contents of the unit. Handouts are attached in appendix 4- section B.

Step 4: Elaborate

Activity Sheets were given to students. They worked in groups.

Anjali and Poojahave to conduct experiment on patterns of longitudinal and transverse waves. To study the factors affecting speed of slinky. Following data sheet was given to them:

Table 4.7: Calculation of Speed of waves:

Medium	Wavelength (cm)	Frequency (Hz)	Speed
Aluminium(Coils of 1 inch diameter)	1.70 cm	3.0 Hz	_____
Aluminium(Coils of 1 inch diameter)	1.90 c m	2.5 Hz	_____
Zinc (Coils of 1 inch diameter)	1.70cm	2.7 Hz	_____
Aluminiumin (Coils of 1 inch diameter)	0.50 cm	3.5 Hz	_____
Aluminium(Coils of 3 inch diameter)	1.95c m	2.7Hz	_____
Copper (Coils of 3 inch diameter)	1.50 c m	1.9 Hz	_____

1. The speed of a wavelength will _____if the wavelength of a wave in a uniform medium increases.

   a. increase b. decrease c. does not change

2. The frequency of a wavelength will _____if the wavelength of a wave in a uniform medium increases.

   a. increase b. decrease c. does not change

3. The wave speed is affected by_____

   a. the properties of the medium

   b. Frequency

   c. Wavelength

   d. wavelength and the frequency both.

Step 5: Evaluate:

Project files were to be prepared to solve the followingquestions:

1. Two waves on Identical strings produce waves of frequencies in a ratio of 2:1. Calculate the ratio of their wavelength if their wave speed are same.

   a. 2:1 b. 1:2 c. 4:1 d. 1:4

2. Mona and Tanya are 8 meters far from each other and are demonstrating the experiment of motion of a transverse wave on a slinky. The wave of frequency 3.5 Hz is produced which has a vertical distance of 28 cm from crest to trough. Calculate the wavelength, speed and amplitude of this wave.

3. Deep and Amar demonstrate the slinky experiment by stretching it, if the wave frequency doubles _____

   a. the wavelength is halved and the speed remains constant

   b. the wavelength remains constant and the speed is doubled

c. both the wavelength and the speed are halved.

d. both the wavelength and the speed remain constant.

4. If a bird's wings beat at 70 beats /second : i) calculate the frequency produced by sound waves.

ii) Calculate the wavelength of the wave, if sound wave has the velocity of 350 m/s, what is the wavelength of the wave.

5. Calculate the speed of waves if the wavelength of a wave is 4.8 meters and if the waves splash once every 5.2 seconds and are at a horizontal distance of 8.6 meters between adjacent crests.

6. Two boats are separated at a distance of 5 meters. They swing on the waves and return to same position at every 4 seconds. No crest are formed between the boats. Determine the speed of waves.

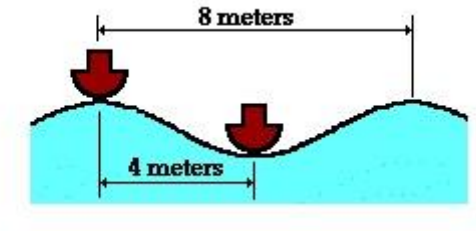


Figure: 4.9: Wave length of waves

4.4.3 Instructional Design 7: Types of Waves: Longitudinal Waves and Transverse Waves Duration: 1 Hour

Objectives:

- Students will be able to explain types of waves.
- Students will be able to explain longitudinal and transverse waves.
- Students will be able to classify between types of waves.
- The students will be able to explain the application of longitudinal waves and transverse waves.

Step 1: Engage:

Demonstration of wave energy by the experiment of slinky

Step 2: Exploration: Students were divided into heterogeneous groups and they were demonstrated the experiment to explore the characteristics of wave in terms of wave propagation.

1) Demonstrating experiment of slinky to observe longitudinal and transverse wave patterns.
2) Demonstrating experiment of patterns water waves
3) Reflection of Waves
4) Attenuation of Waves

Group discussion was among groups to identify the types of waves.

Step 3: Explanation: Whole-class discussion, demonstrations, and direct-teach activities.

Students report their observations and findings from the Exploration activities.

Demonstration of Wave patterns in Solids and Liquids.

Students were asked to identify vocabulary related to wave patterns on power point presentation: longitudinal wave, transverse wave, crest, trough, amplitude, wavelength, frequency, period, compression, dilation

5) Slinky wave generator: demonstrating wave patterns and *Wave Propagation in All Directions*

Comparing average wave speed or frequency of ocean waves, waves formed by tsunamis, sound waves produced by loud speakers, electromagnetic waves, etc.

Step 4: Elaboration: Following Power Point Presentation were shown to students

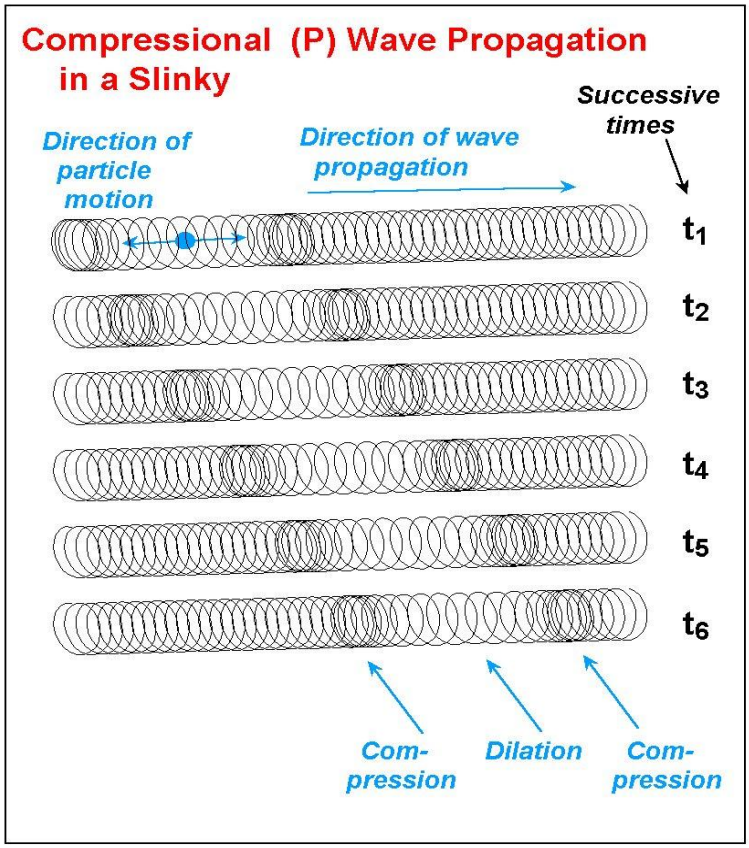
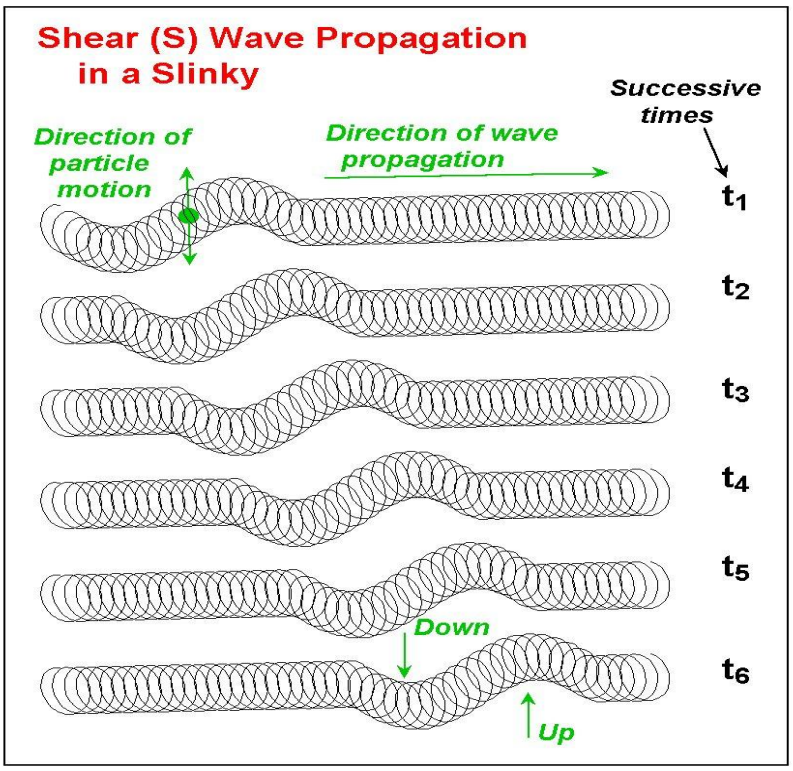


Figure 4.10: Compressional (P) wave propagation in a slinky.

If a wave is disturbed at one end, compression is formed which is propagated and followed by dilation (extension). Successive propogation of dilation can be observed in the figure 4.10. As the energy passes, the coils of the slinky are left at their positions without any change observed.



(For transparency)

Figure 4.11: Directional wave propagation in a slinky

The student who demonstrates the shear disturbance keeps moving his hand quickly up and then down. Along the slinky, a motion of the coils that is perpendicular to the direction of propagation is generated. The particle motion is perpendicular to the direction of motion and also to the vertical plane. Shear waves can also be produced with the slinky wherein the motion is in the horizontal plane by the student creating the source and keeps moving his or her hand quickly left and right. The wave propagation is illustrated in Figure 14. It is to be noticed that though the disturbance in motion was perpendicular to the direction of propagation, the disturbance propagated away from the source alongside the slinky.

Step 5: Evaluate: Make a project file for an assignment by

- Identify the type of waves, mark crest, trough, wavelength, amplitude of waves in the photographs and diagrams of waves collected from pictures.

- Diagrams of wave interactions were given. Students marked the boundaries, and made arrows to show the wave direction before hitting the boundary and returning after hitting the boundary. Make a sketch of the wave front formed.

4.4.4 Instructional Design 8: Interference and its types: Constructive and Destructive Interference Duration: 1 Hour

Objectives:

Students will be able to explain Interference of waves

The students will be able to understand types of interference of waves.

Students will be able to explain examples based on real life application on types of Interference of waves

Step 1: Engage

Power point presentation of below mentioned images were shown to the class.

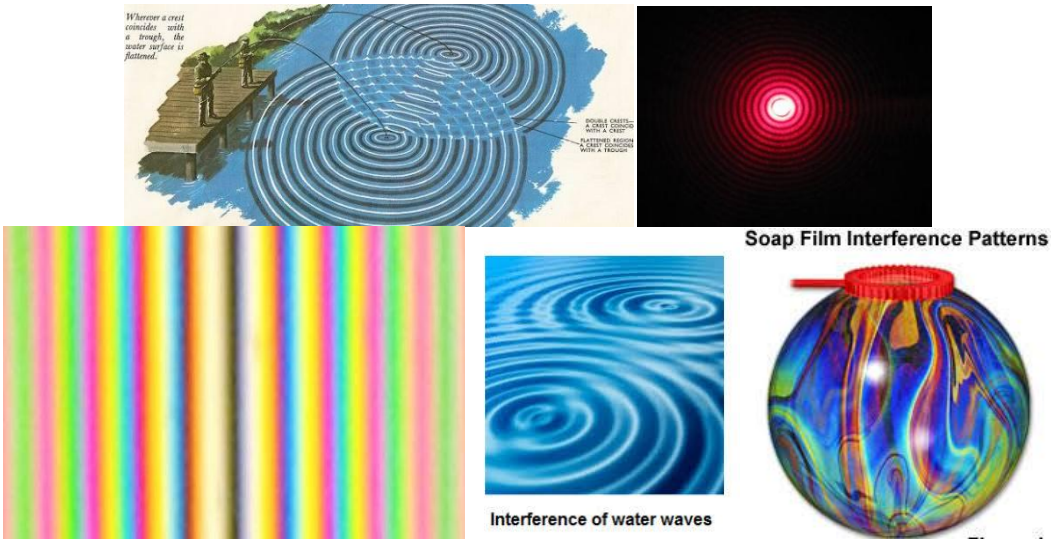


Figure 4.12: Interference of waves

And then following questions were posed to the class.

What is presented in slides?

Is there any pattern observed in waves?

How is it?

It is meeting of waves and disturbance in waves?

If one wave meets another, how is the pattern formed?

They can generate bigger waves or may also cancel each other.

Do the waves make one giant wave by converging? Or do they destroy each other?

Step 2: Explore

Demonstration: Two students will perform the experiment and other students will watch carefully: One student will Jump over the rope forming wave patterns with it. Each of the student holding one end of the rope, and both swinging up and down, creating giant wave patterns toward each other down the length of the rope. Waves would make crazy patterns by jumping ropes and sorting crash into each other. Standing waves produce intriguing phenomena that occur when two waves interfere with each other. To understand what happen, learning more on how **interference** really works.

Step 3: Explain: Teacher explained to students the contents of the unit. Handouts are attached in section B.

Step 4: Elaborate

Slides were shown and student's discussion in groups was done.

Figure 4.13: Constructive and destructive interference waves

Step 5: Evaluate

- Prepare the project file for real life application examples of interference of waves.
- Write the definition of interference and explain its types.

4.4.5 Participant Observation for Unit II: Sound and Waves

- All the students observed the power point presentation on waves, types of waves and responded positively to the questions asked by the researcher.
- Most of the students solved the examples given in the activity sheets on waves while a few students solved with the help of their group members.
- All the students surfed the websites for the real life applications of sound and waves and made project files.
- One of the student said: “The applications of waves are amazing in medical fields, I searched all from websites”.
- Students carefully watched the experiment of longitudinal and transverse waves done on slinky and discussed the observations in the experiment.
- Students enjoyed in performing the experiments on waves. One of the students said: “Madam can we do such experiments in all our physics classes? As we understand better.”
- Students helped each other in arriving at the concept of waves and its parameters.
- Students listened carefully to explanation and answered the questions actively.
- More number of hands was raised to answer the questions asked by researcher, student found difficult to wait for their turn to answer and tried to correct their group members if they found them wrong.
- One of the students said: “Madam shall I go and see whether the other group has solved the examples correct, as I have finished all examples correctly”.
- One of the students said: “ I wait for physics lecture so that I can perform the role of speaker this time and present my group in front of whole class.”

4.5.0 Unit III: Light

- Properties of light: Reflection and Refraction of Light
- Dispersion of light
- Resonance of light
- Interference of light

4.5.1 Instructional Design 9: Properties of Light: Reflection and Refraction

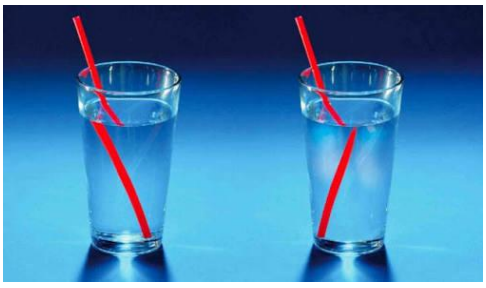
Duration: 1 Hour

Objectives:

- Students will be able to state properties of light
- Students will be able to define reflection of light and refraction of light.
- Students will be able to explain applications of reflection and refraction of light in real life situation.
- Students will be able to explain laws of reflection and refraction.
- Students will be able to understand Snell's Law and its real life applications.

Step 1: Engage

Power point presentation of reflection and refraction of light were demonstrated.



(1)

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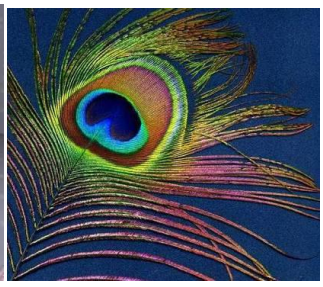

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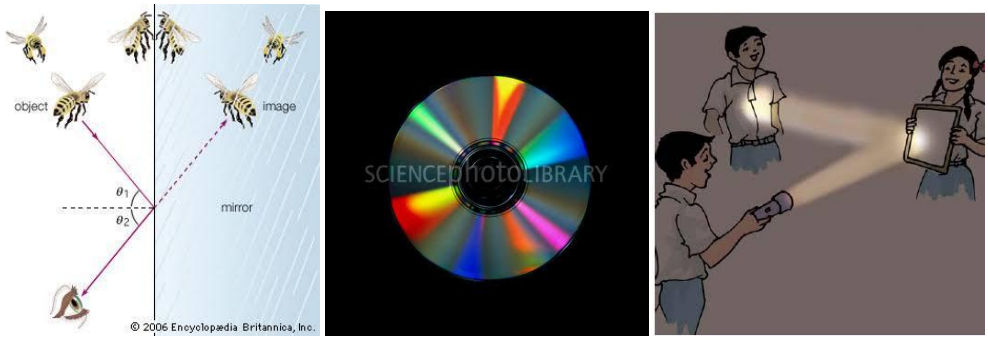


(4) (5) (6)

(7) (8) (9)

Figure 4.14: Reflection and Refraction

Step 2: Explore

Activity sheets were provided to students with guided questions:

Q1) What are slides about?

Q2) Is it related to light?

Q3) What is reflection of light?

Q4) What is refraction of light?

Q5) Classify the slides based on reflection and refraction of light phenomenon.

Table 4.8: Reflection and Refraction of Light

Sr. No.	Reflection	Reason	Refraction	Reason

For slide 1: If a pencil is placed in a glass of half filled water, what can be the shape of the pencil?

Students' predictions may be pencil will look the same inside and outside water. Or the image of the pencil can be viewed magnified or may be the pencil seems to be broken.
How is the shape of pencil appeared placing in the water? It appears to be broken when the pensil enters to water medium from air medium. Do light behave the same in all forms of matter- gas, liquid, solid? No, light travels at different speeds in all the three media, it travels fastest from gas then from liquids and lastly the speed is decreased in solids.

Slide 4: How does refraction be related to spearfish from a riverbank?

Light bends when it enters the water medium from the air medium due to refraction. To hit the fish below the surface of the water, fish is actually in a different position than perceived from above the water must be taken into account. Fish is to be to aimed in front to actually hit it.

Step 3: Explain: Teacher explained to students contents of the unit. Handouts are attached in appendix 4- section B.

Step 4: Elaborate: The students applied their conceptual understanding and skills to solve a problem, make a decision, perform a task, or make sense of new knowledge. Using the diagram, Power point presentation will be shown, along with what you learned from the explanation about refraction to answer this question: If you are spear

fishing from a riverbank and you see a fish in the water, do you need to aim above, at, or below the fish that you see in order to hit it? Defend your answer in three or more well written sentences. You can draw a diagram to help explain.

Hints given: Answer should include: Light bends when it enters the water due to refraction. In order to actually hit the fish, you must take into account that the fish is actually in a different position than you perceive from above the water. Since light going from air to water bends toward the "normal" or an imaginary line that is 90 degrees to the surface of the water, you should aim in front of the fish to hit it.

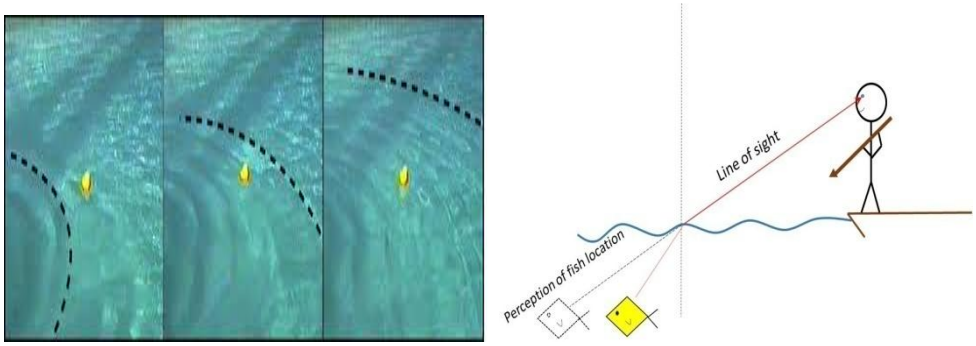


Figure 4.15a: Angles of incidence

What did students knew and be able to do as a result of this lesson?The students will be able to classify the properties of light: reflections, refraction and would be able to apply the information they learned about refraction to a real life situation.

Refraction and Angles

Refraction is the phenomenon which causes a change in the direction of a wave when a wave is passed from one medium to another. A light wave travels at a certain speed through air and it travels with different speed from water. Thus when the medium of wave propagation changes from one medium to another it always changes its speed and bends from a rarer medium to denser medium. This is called refraction of light.

Refraction and reflection are two properties of light different. Reflection is the result of the direction of wave striking a surface and it bounces of a surface, while refraction is the phenomena of change in direction of wave when it is propagating from one medium to another.

In reflection and refraction both, when a light ray enters a medium striking a surface, it forms the angle of incidence which is formed between the incident ray and the normal. The normal is a line drawn at the perpendicular of the surface. In re direction of the normal forming angle of reflection.

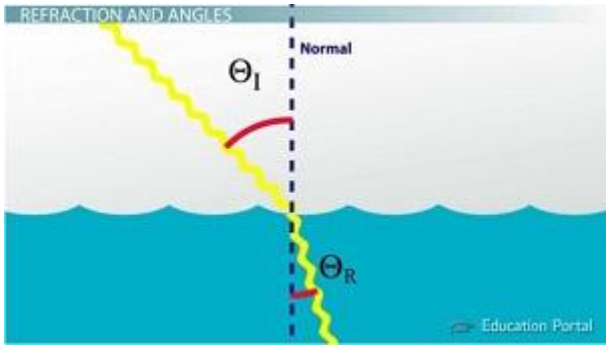


Figure 4.15b: Angles of incidence

Angle of incidence and angle of reflection of a wave in water surface are shown in figure 4.15b. The line separating the two medium of air and water is the normal. Refracted ray is the light wave passing from the first medium into the second making **angle of refraction** i.e. the angle between the refracted ray and the normal line. We use the abbreviation for the angles with the symbol theta. Angle of incidence 'theta I', and 'theta R' for the angle of refraction. Refracted ray doesn't continue along the same trajectory as the incident ray, nor does it make a perfect reflection or a 90-degree angle with the ray. The amount of bending that occurs between the two rays depends on the first medium, the second medium, and the properties of the wave itself.

Step 4: Elaborate: Index of Refraction

All different mediums like air, water, glass have their own properties. The wave travels faster in outer space than in any other medium. Thus there is the difference in the speed of waves travelling between all mediums. The difference in number between the speed of light in any other medium is known as index of refraction. It shows the refraction of light wave. It is given by $n = c / v$, where c is the speed of light in a vacuum, and v is the speed of light in the medium. As light wave travels faster in vacuum the ratio of the two speeds is always greater than or equal to=1.

Step 5: Evaluation

Make a project file for

- The application of laws of reflection and refraction in real life situation.
- Define reflection. Write laws of reflection.
- Define refraction and explain laws of refraction.

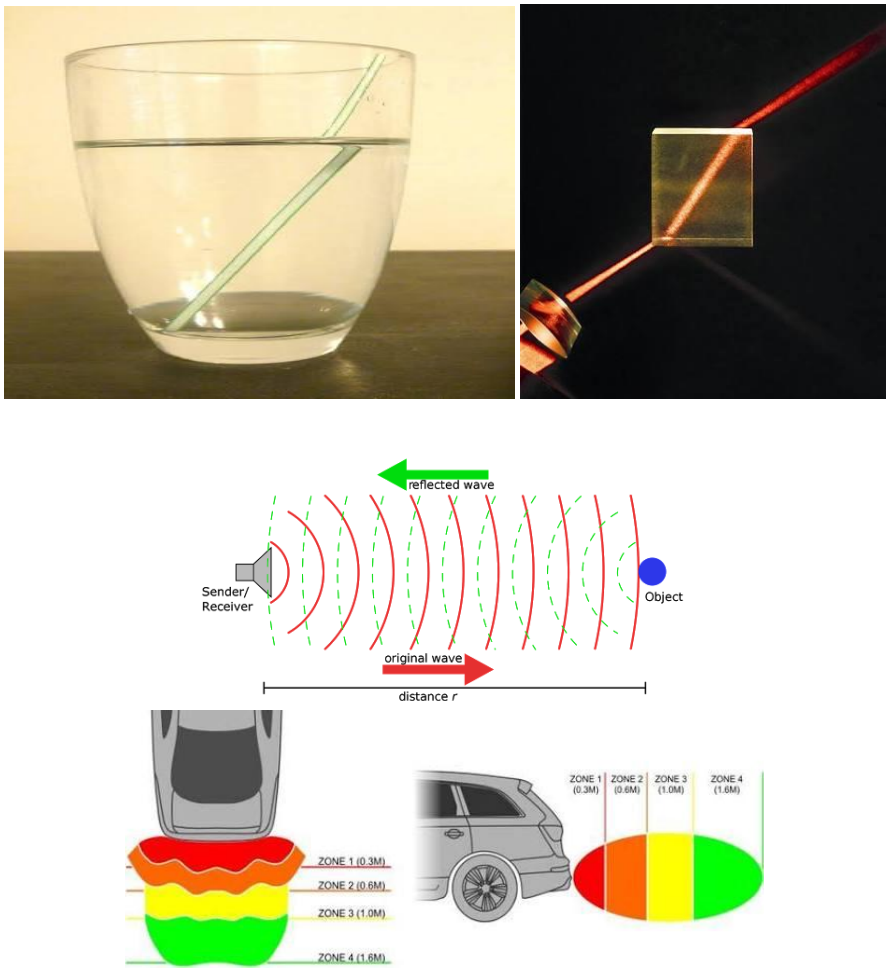


Figure 4.16: Reflection of waves in car sensors [Project Files Made By Students At Home]

4.5.2 Instructional Design 10: Dispersion of Light Duration: 1 Hour

Objectives: Students will be able to identify dispersion of light.

Students will be able to define dispersion of light.

Students will be able to explain application of dispersion of light.

Step 1: Engage: Power Point Presentation was shown

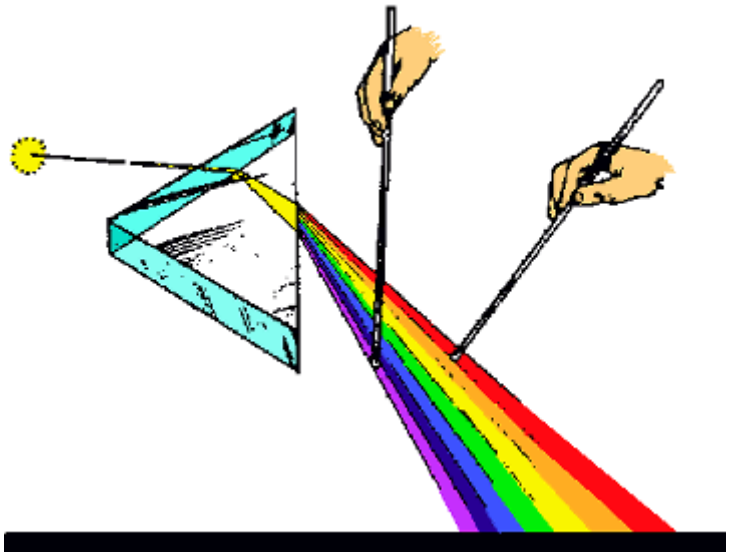


Figure 4.17: Light when it passes through the prism

Assigning the activity sheets with the following questions:

Questions in activity sheet:

a) Explain what happens to white light when it passes through the prism.

b) How is the color of the light we see and its wavelength associated?

c) How might you explain that white light (made up of all visible wavelengths) can be dispersed into its constituent wavelengths?

d) Which wavelength seems to be affected the most? The least?

Step 2: Explore:

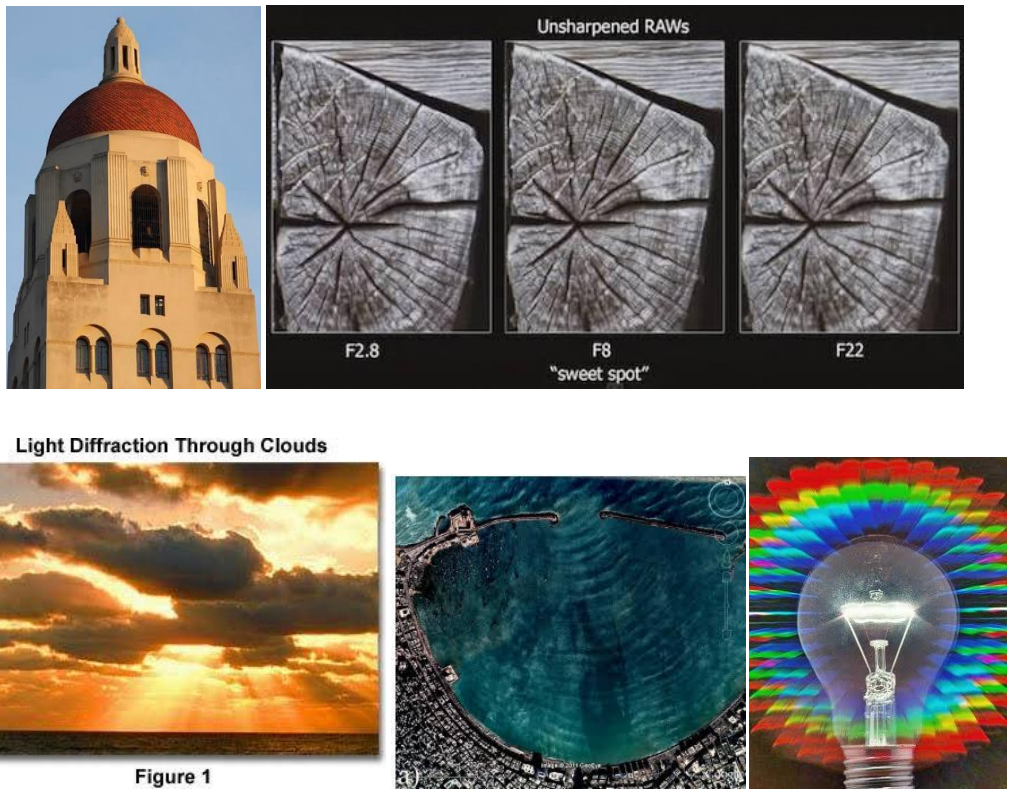


Figure 4.18: Dispersion of Light

Step 3: Explain: Teacher explained to students contents of the unit. Handouts are attached in appendix 4- section B.

Step 4: Elaborate: Each group of students was provided with the following materials:

Large glass filled with water and one glass with whole milk, bright torch light forming beam, cardboard having a small hole at the centre.

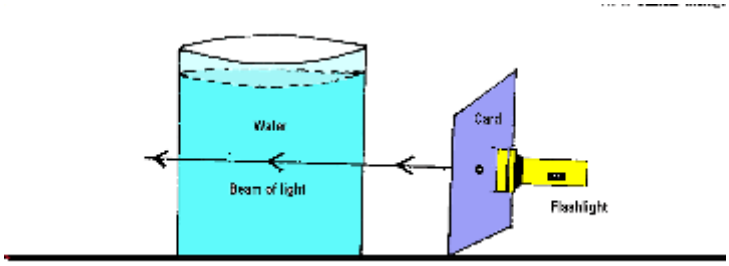


Figure 4.19: Light passes through a medium

Procedure of the experiment was explained to all the groups of students.

A large glass of water would be allowed to rest for 5 min to settle down all Particles in it.

Putting the cardboard in front of the flashlight's light beam so that it is touching the flashlight and a thin beam of light is coming out from the hole.

Then, aiming the beam of the flashlight towards the glass so that it is passing through the water.

The room was very dark, and the water very clean, decrease in light emerging on the opposite side of the glass, was not much seen.

Slowly adding more milk to the glass of water, taking note of the shape of the beam and the amount of light making it all the way through the water.

Questions

Does the amount of light reaching the opposite side of the glass change when you add the milk? Explain how does it happen?

As more and more milk is added, the light coming into the glass is scattered in more directions, thus less of it is able to make it all the way through the glass. (This is similar to the presence of sulfuric acid droplets in the stratosphere and their effect on sunlight).

Note: This demonstration works best with a small aquarium to hold the water, as the sides of the aquarium are flat and the flashlight can be placed directly against one side of the aquarium.

Step 5: Evaluate: Prepare a Project file through internet search from different websites for Dispersion of light in daily life application.

Explain Dispersion.

4.5.3 Instructional Design 11: Superposition of Waves Duration: 1 Hour

Objectives: Students will be able to explain superposition phenomena in waves.

Students will be able to define superposition of waves

Students will be able to explain applications in real life of superposition of waves.

Step 1: Engage: Following questions will be posed to students:

What do ripples on puddles do?

How do waves on ropes are produced?

What do noise-cancelling headphones have in common?

Step 2: Explore: Power point presentation

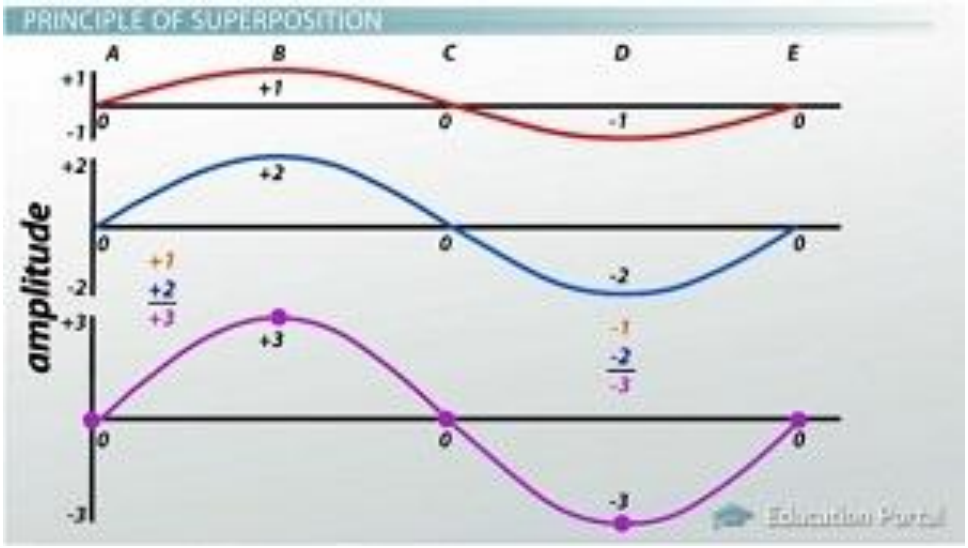


Figure 4.20: The principle of superposition

Step 3: Explain Teacher will explain to students contents of the unit. Handouts are attached in section B.

Step 4: Discussion among students groups: The waves forming patterns of crest and troughs leads to the principal of superposition of waves.

Demonstration of waves by lining the waves in a differently by forming patterns of waves. Shifting the second wave on the first waves such that the crest of first waves lies on the trough of the second wave. So that at point A, C and E, the sum of both waves is equal to zero over so that its crest lines up with the trough of the first one. At

point B, The crest of first wave is over the trough of the second wave. Due to this there is destructive interference. It means that the resulting amplitude is minus *1*. At point D, the destructive interference of *minus 1* trough is over *plus 2* crest forming the amplitude plus *1*.

As you can see, the principle of superposition helps us find the resulting amplitude for every point along two interfering waves.

Step 5: Evaluate:

- Search on websites applications principle of superposition and prepare a project file.
- Write a short note on superposition of waves with labeled diagram.

4.5.4 Instructional Design 12: Resonance **Duration: 1 Hour**

Objectives:

- Students will be able to explain resonance.
- Students will be able to define resonance in scientific terms.
- Students will be able to explain resonance in real life applications in their own words with suitable illustrations.

Step 1: Engage

Power Point Presentations were shown to students:

Figure 4.21: Resonance

Posing Questions

- What is shown in slides?
- Is it the phenomenon related to sound, light or water?
- Explain the phenomenon.

Step 2: Explore

Discussion sessions:

How do beautiful music is produced with wine glasses?

How a wine glass be broken by singing loudly in front of it?

How can sound waves do some pretty neat things when we know how to use them in our daily lives.

Light waves also interact in special ways with the objects around them.

Step 3: Explain: Teacher explained to students contents of the unit. Handouts are attached in appendix 4- section B.

Step 4: Elaborate: Power Point Presentation

Figure 4.22: Resonance of Light Waves

Discussion among students with respect to following questions posed:

Why is the color of snake black?

The snake appears black because its skin absorbs all frequencies of sunlight

Transmission and Resonance of Light Waves

Is the light wave coming from the sun be a typical light wave?

We'll say it's a stream of white light that comes from the sun.

Is it a dark object? Name it?

A dark object, like a western rat snake slithering through yard

Is there the same phenomenon happening?

The molecules in the snake's skin have a set of resonant frequencies.

Explain the phenomenon.

The electrons in the atoms are vibrating with certain frequencies. The light from the sun is white in color. Thus it has many frequencies due to white color of seven basic primary colors of red, yellow, orange, green, blue, indigo and violet. All

of these frequencies are striking the snakes skin. All these frequencies will make electrons vibrate differently. The yellow frequency will resonate with the electrons yellow frequency. And same will apply for all other colors. Thus, the skin of snake will resonate with the light of the sun. There is high vibration in electrons when they resonate with light waves of an object. The energy from light gets absorbed by the object, and we are not able to see it. As a result the object appears black. As a snake absorbs all the frequencies of sunlight it appears as a black snake.

Figure 4.23: The glass appears clear because it does not absorb any sunlight

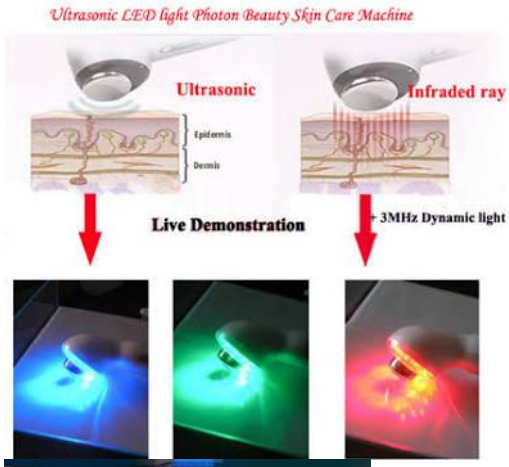
What if an object does not absorb any of the sunlight? What if none of its electrons resonate with the light frequencies? If resonance does not occur, then what will you get? You'll get is **transmission**, the passing of light waves through an object.

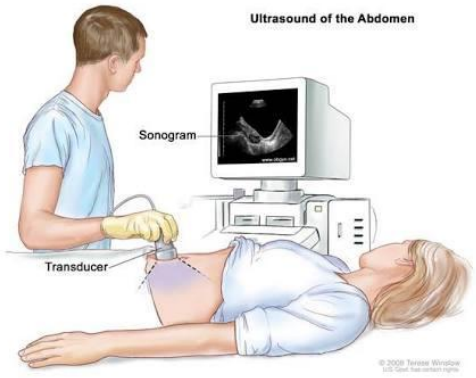
Explain the phenomenon,

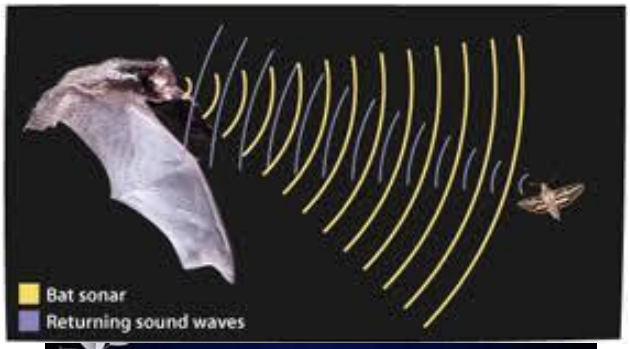
The vibrations of the electrons are there sue to light electrons. The vibrations are very small as they are not matching the electrons' resonant frequencies pass from atom to atom throughout the object. An object with no resonance exhibits zero absorption, and thus there is 100% transmission. So, in this case the object would appear clear, like glass or water.

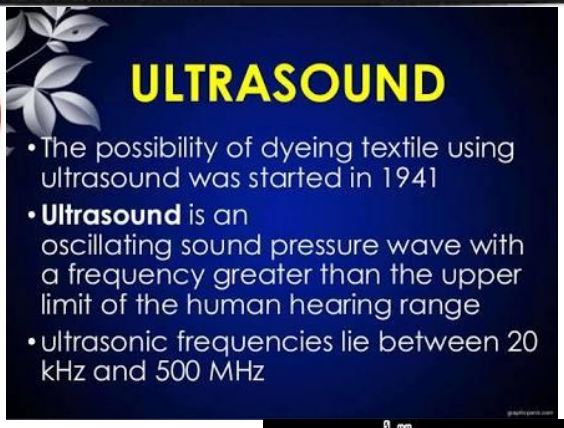
Step 5: Evaluation

- Make a project file by searching from websites on resonance used in daily life applications.
- Define Resonance and explain its importance.
- Explain Resonance.


Ultrasonic LED light Photon Beauty Skin Care Machine
Ultrasonic
Infraded ray
Epidermis
Dermis
Live Demonstration
+3MHz Dynamic light


Ultrasound of the Abdomen
Sonogram
Transducer


Bat sonar
Returning sound waves


ULTRASOUND
• The possibility of dyeing textile using ultrasound was started in 1941
• Ultrasound is an oscillating sound pressure wave with a frequency greater than the upper limit of the human hearing range
• ultrasonic frequencies lie between 20 kHz and 500 MHz


The world's first 100% ultrasonic toothbrush
Motionless, gentle cleaning and whitening without brushing or friction.
100% ULTRASOUND
CLEANS GENTLY WITHOUT BRUSHING
Ideal for sensitive teeth or receding gums.


NAME
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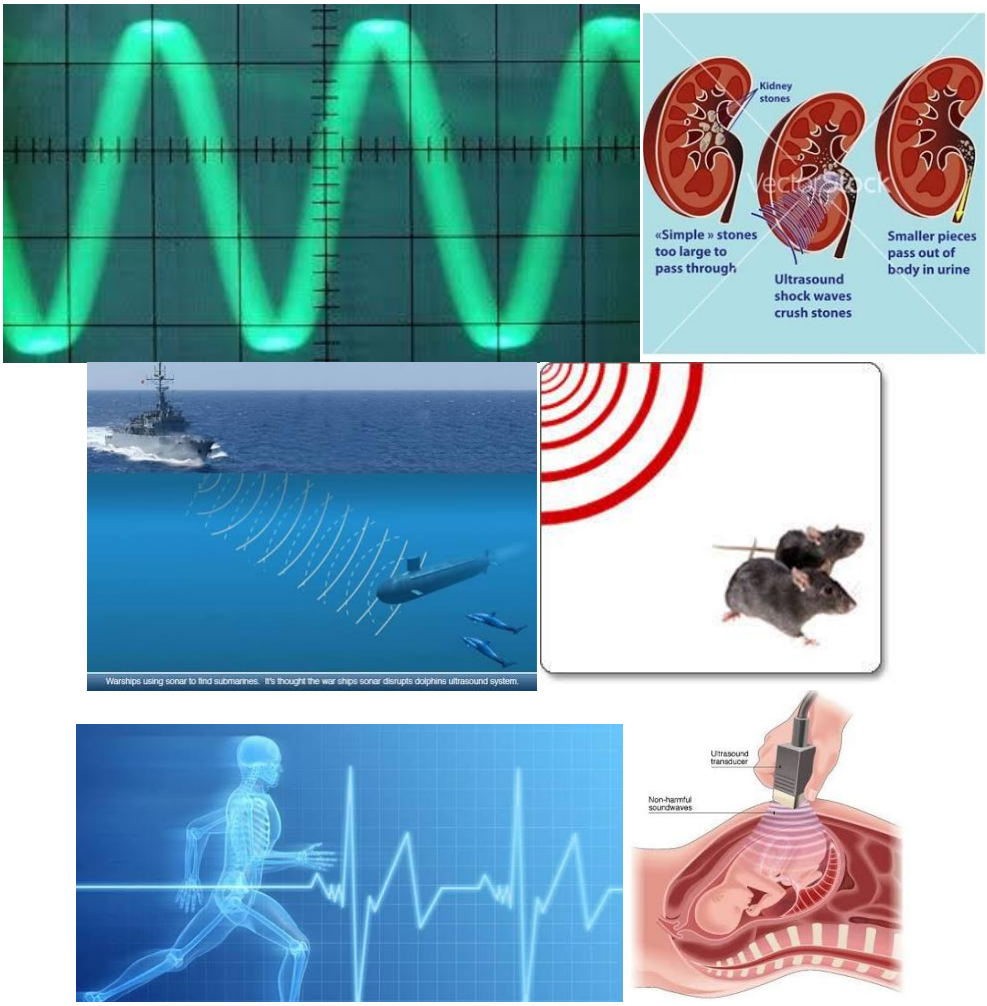

Figure 4.24: Applications of resonance (made by students at home)

4.5.5 Participant Observation for unit III: Light

- Most of the students answered individually the activity sheets given to them on light, while few took help of their group members to write the differentiation between reflection and refraction of light.
- All of the students formed the groups and performed the roles of speaker, recorder and performer and shared their readings in groups.
- All of the students shared their knowledge on behalf of whole class with the roles of speakers assigned to them.
- All the students listened to the explanation carefully by researcher to the contents of Light
- All of the students answered the question carefully by thinking to the questions posed by the researcher.

- All of the students helped their group members to write the correct formulas of the derived quantities.
- One of the student said “I will also try to make a musical sound on glass by the resonance phenomenon at home.”
- Most of the students personalized their knowledge by reflecting on the concepts of physics taught in the evaluation step on daily life applications of light.
- Few of the Students did very well in evaluation step in their project file.

4.6 Overall reflections on implementation of instructional design

The constructivist sessions were held for three units of the common topics of civil and electrical branches of diploma engineering. The researcher conducted the sessions and also made Researcher’s Observation of students during instructional process during the sessions. The students were found quite motivated with high spirit and were enjoying the sessions. The students if were not able to follow had easily solved their doubts with their group members and teacher. They were able to link their prior knowledge with the new gained knowledge and reflected on their new understanding. The students did very well in the evaluation part by searching more information and connecting the basic physics concepts with the core engineering applications in day-to-day life. The group discussion and social negotiation of knowledge was found effective in the teaching-learning process. Thus, overall the constructivist sessions were helpful in teaching-learning physics at diploma engineering level.

The present chapter dealt with process of preparation of instructional design and its implementation at the classroom of the diploma engineering level. The next chapter deals with data analysis and interpretation.